PATENT SPECIFICATION

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Complete Specification Accepted : April 21, 1939.

504,214
No. 2962/38.

COMPLETE SPECIFICATION

Improvements in and relating to Turbo Compressors

We, RHEINMETALL-BORSIG AKTIENGESELLSCHAFT WERK-BORSIG BERLIN-TEGEL, of Werk-Borsig, Berlin-Tegel, Germany, a Body Corporate duly organised under the Laws of Germany, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to turbo compressors.

In turbo compressors, particularly axial flow blowers, the rotor and guide blades of which have supporting surface profiles, the well - known flow separation of the boundary layer manifests itself at the outer and inner boundaries of the delivery passages. The flow separation of the flowing medium from the walls of the passages is the result of the losses which arise in the conversion of the velocity energy into pressure energy by friction and the formation of eddies in the movement of the boundary layer which is retarded to a zero value. In consequence of the flow separation of the jet the pressure ratio which is attainable in one stage of the compressor is limited to a value of about 1.25. Accordingly, a comparatively large number of compression stages and therefore a great constructional length of the compressor are necessary in order to obtain a particular delivery output. In addition, shafts of very large diameter are necessary if the compressor is to be driven at high speeds in spite of the reduced critical speed caused by the great constructional length. The comparatively large amount of space occupied and the great weight which results are very objectionable in portable plants.

In order to avoid these drawbacks it is proposed by the present invention to prevent the flow separation of the jet at the boundary layer by suction similar to the suction obtained with the supporting surfaces or aerofoils of aircraft. For this purpose it is proposed according to the present invention, to connect the gap on the inlet side of the delivery passages of the rotor wheel with the delivery passage itself by suction passages. The same arrangement may be also adopted for the guide wheels of axial flow compressors and of the guide apparatus of radial compressors. By doing so those parts of the boundary layer which possess no energy and which flow in a substantially laminated form are drawn off. The higher static pressure of the drawn-off delivery medium is simultaneously utilised at the point at which it is introduced again, to accelerate the boundary layer or bring about an exchange of energy with the core current. Consequently the pressure ratio which is attainable in one stage can be raised from the value of 1.25 above given, to about 1.35 to 1.40, whereby a reduction in the number of stages of the compressor results and important advantages as regards weight and the amount of space occupied are obtained.

The invention will be further described with reference to the accompanying drawings wherein various embodiments illustrating the application of the invention to axial flow compressors are shown.

Figs. 1 and 2 being a detail section and perspective view respectively of one embodiment,

Figs. 3 and 4 views similar to Fig. 2 of alternatives and Figs. 5 and 6 show further alternative arrangements.

In the drawings referring first more particularly to Figs. 1 and 2, the rotor wheel 1 is furnished between the leading and trailing edges of the blade 6 with suction openings 12 which are connected by passages 11 with the rotor wheel gap 4 on the inlet side of the blades 6. In this way the outlet sides of the delivery passages 8 framed by the blades 6 and the outer casing 7 are so connected with the rotor wheel gap 4 on the inlet side that flow separation is prevented since a portion of the medium to be delivered is drawn off through the passages 11 from the outlet side and is mixed with the incoming medium.

The inlet openings 9 are conveniently nozzle shaped and arranged obliquely in the direction of flow as is known *per se*.

Moreover the boundary layers are accelerated at the ends of the delivery passages 8 owing to the fall of pressure occurring up to the point at which the

medium to be delivered is drawn off, the residual excess pressure being utilised to accelerate or create turbulance in the boundary layer.

The passages 11 are holes or slots suitably cut in the rotor disc 1 communicating with the openings 12 which may be cut out radially from the body of the disc with milling cutters and which are preferably located at the point where flow separation of the boundary layer is otherwise likely to occur.

As shown in Fig. 1, corresponding balancing passages 13 may be formed in the casing 7, the openings 9' to which may be nozzle shaped and disposed obliquely in the direction of floor as clearly shown in this figure. The arrangement of passages formed as nozzles and disposed obliquely in the direction of flow is, however, not *per se* novel.

Fig. 3 shows the arrangement of the passage for drawing off the medium to be delivered in a rotor wheel which is composed of the blades 14 and the wheel disc 1. In this case the stem of the blade has a milled out recess 15, which is connected by the hollow space 16 and the hole 17 with the gap 4 on the inlet side.

In Fig. 4 is shown an arrangement which enables a portion of the compressed medium to be drawn back to the inlet side both directly from the delivery passage 8 of the rotor wheel enclosed by the blades 6 and from the gap 5 on the outlet side of the rotor wheel. For this purpose passages 3, which connect both sides of the wheel with each-other, and passages 11, which communicate with the opening 12 for drawing off the medium from the delivery passage, are provided.

Fig. 5 shows the double arrangement of the passages for drawing off the medium to be delivered both on the inner and also the outer boundaries of the passages. The drawing off of the medium to be delivered is effected through the passages 3 and 11 provided in the rotor wheel 1 and the passages 13 and 18 provided in the casing 7. The passage 18 communicates in this case in the same way as the passage 11 with the delivery passage 8 through an opening 20 in the interior thereof.

The passages through which the medium to be delivered are drawn off may also be arranged in the guide wheels of the compressor in the same way as in the rotor wheels.

In Fig. 6 is shown an axial flow compressor in which the drawing off of the medium to be delivered is carried out both inside the rotor blades 6 which bound the delivery passage and inside the guide blades 26. The construction and arrangement of the passages may be the same as or similar to that employed in the constructions shown in Figs. 1 to 7 and may be adapted to the particular construction of the guide apparatus and the wheel discs.

It will be understood that the invention may equally well be applied to radial-flow turbo-compressors and that the suction passages according to the invention may be provided in the guide wheels or in the rotor wheels or in both sets of wheels.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An arrangement for preventing flow separation of the jet inside the delivery passages of turbo compressors characterised by the fact that suction openings (12, 15) are provided between the leading and trailing edges of the blades of the rotor and are connected by passages (11, 17) with the rotor wheel gap on the inlet side of the blades.

2. An arrangement according to claim 1, wherein similarly arranged suction openings (20) and passages (18) are also provided in the parts of the casing surrounding each row of rotor blades.

3. An arrangement according to either of claims 1 or 2, further characterised by the fact that the rotor wheel gap (4) on the inlet side of the medium to be delivered is also connected with the rotor wheel gap (5) on the outlet side.

4. An arrangement according to claim 1 to 3, characterised by the fact that the mouths of the rotor wheel gap (4) are arranged slantingly in the direction of flow and the rotor wheel gap is constructed on the inlet side of the medium to be delivered in the form of annular nozzles (9).

5. An arrangement for preventing the flow separation of the jet inside the delivery passages of turbo-compressors, characterised by the provision of suction passages of a construction corresponding to claims 1-4 in the guide wheels (26) of the compressor.

6. An arrangement for preventing the flow separation of the jet inside the delivery passages of turbo - compressors with axial flow wheels, characterised by the provision of suction passages according to claims 1-5 in both the rotor wheels (1) and the guide wheels (26) of the compressor.

7. Arrangements for turbo-compressors constructed and adapted to operate substantially as described with reference to the accompanying drawings.

Dated this 31st day of January, 1938.

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London, S.W.
Agents for Applicants.

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FIG. 1.

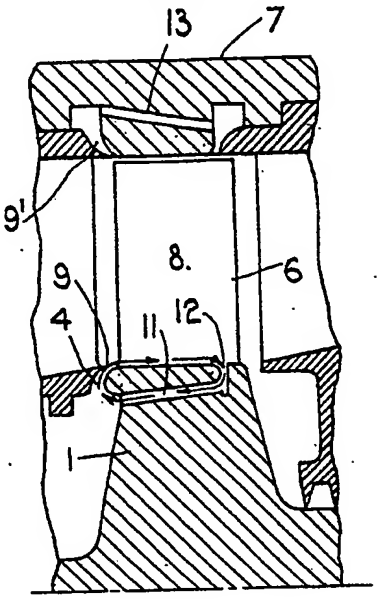


FIG. 2.

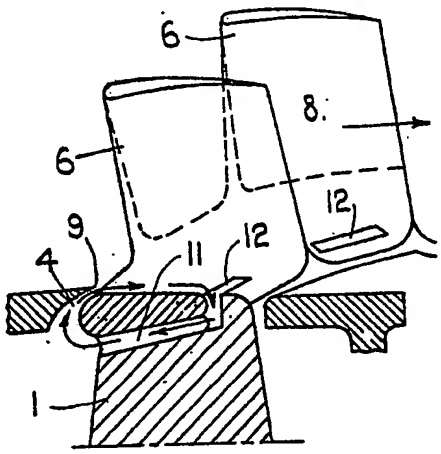


FIG. 3.

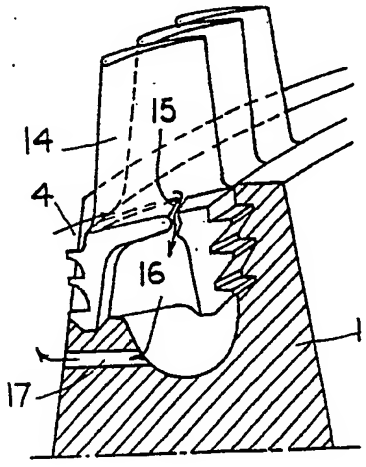


FIG. 4.

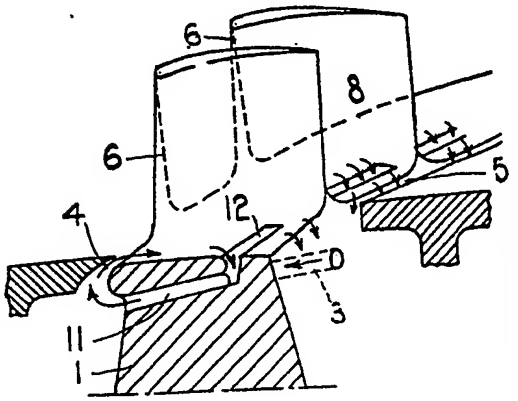


FIG. 5.

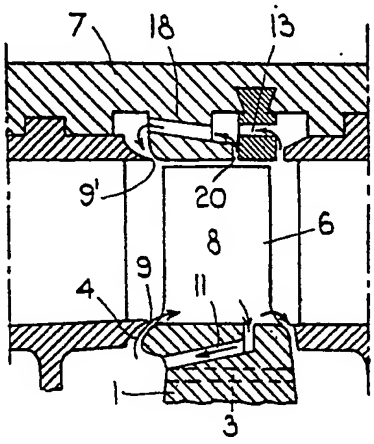
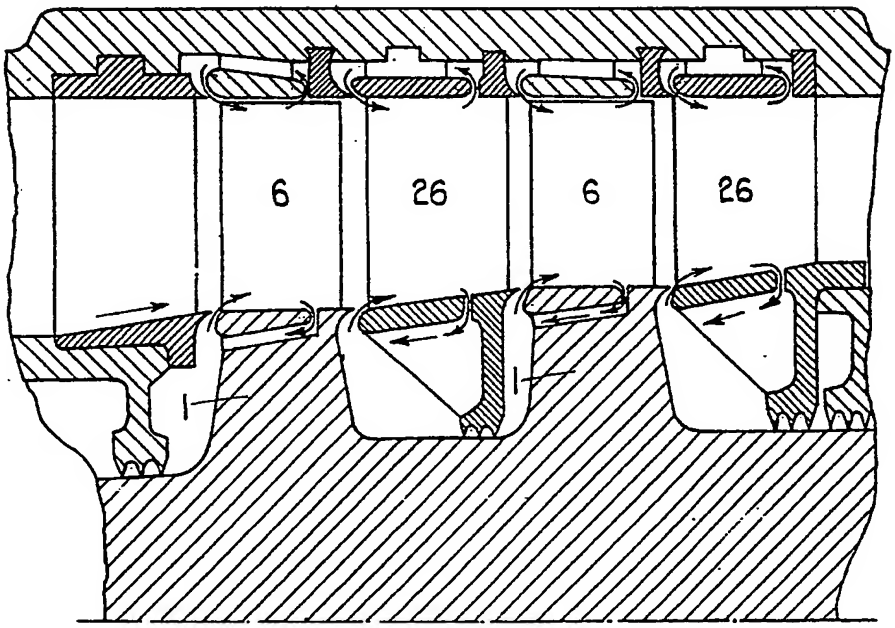


FIG. 6.



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SHEET 1

2 SHEETS
SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale]

FIG. 1.

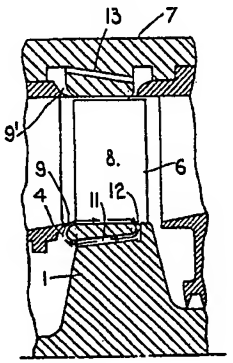


FIG. 2.

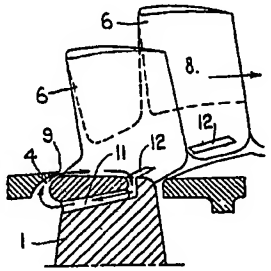


FIG. 3.

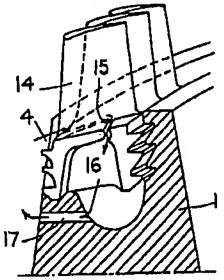


FIG. 4.

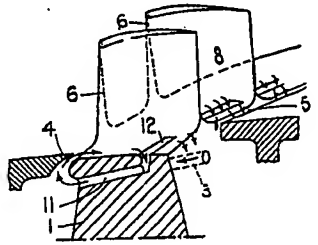


FIG. 5.

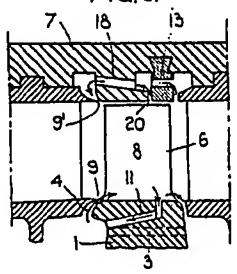
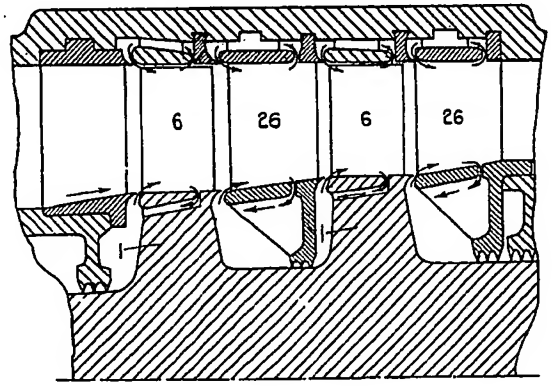


FIG. 6.



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